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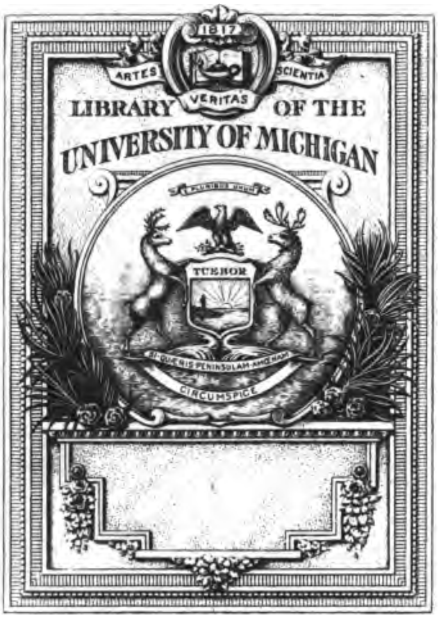

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AN ACCOUNT

OF A

METHOD OF

ETCHING OR ENGRAVING

Viâ Siccâ,

BY MEANS OF

VOLTAIC ELECTRICITY.

BY JAMES H. PRING, M.D.

Formerly Physician to the Bath General Hospital,
&c., &c.

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1848.

The object of the following pages is merely to furnish a short account of a process which has already been made the subject of description in the scientific journals, and formed the substance of a paper which was read before the Royal Society in 1846; of which latter the present brief notice is to be regarded as little else than a reproduction in a separate and somewhat less ephemeral form.

The multiplication of such terms as anode and cathode, zincode, and platinode, &c., by which it has been sought of late years to replace the old appellation of positive and negative, as applied to the poles of a galvanic battery, if not tending actually to increase any previously existing confusion, seems rather to serve as an evidence of the difficulty which has been experienced in treating of this question, than to prove that it has been in any degree successfully disposed of.

Under these circumstances therefore, I have endeavoured as far as possible to avoid the introduction of these terms, and have for the most part simply contented myself with indicating the element of the battery with which the wires employed may, respectively, be in connection.

Weston-super-Mare, Sept. 1848.

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AN ACCOUNT OF

A METHOD OF ETCHING OR ENGRAVING,

BY MEANS OF

VOLTAIC ELECTRICITY.

THE ignition or deflagration of the metals has long been known as one of the powerful and varied properties of the electric agency. Whilst however, it has, until very recently, been invested with no peculiar interest beyond that which attaches to a scientific fact devoid of any practical utility, the process which forms the subject of the present notice, promises not only to render this power of electricity of practical use in the Arts, but also to add somewhat to the present amount of our knowledge respecting it in a scientific point of view.

The method of Etching or Engraving by Voltaic Electricity about to be described, and first made known in the pages of the Philosophical Magazine for August, 1843, differs materially from the process detailed under a similar appellation by Mr. Smee and other writers, about the same period. The former consists in the employment of a wire used as a dry point, aided by the electro-galvanic power, as the etching or graving tool; the latter is effected by making a copper plate, prepared in the manner resorted to in ordinary etching, to form the positive pole in the decomposition cell of a galvanic circuit, when the exposed metallic surface, forming the design, is dissolved by the aid of the galvanic current, in place of being acted upon in the usual way by nitric acid.—In the language of the older chemists, the one process may be designated as electro-engraving, *viâ humidâ*, whilst the other, in contradistinction, may with propriety be styled electro-engraving or etching, *viâ siccâ;* the transfer of the metal from one pole of the battery to the other being in the latter instance effected by direct contact of the poles themselves, without the intervention of any fluid conducting medium. A difference is likewise found to obtain between the two processes as regards the metals upon which their power may respectively be employed, and the nature and appearance of the effect produced; the process described by Mr. Smee being applicable more especially to copper for the common purposes of engraving, whilst that at present under consideration is almost limited in its application to steel, and more particularly to steel in its hardened state, for the purpose of producing ornamental designs, &c., rather than of proving a substitute for engraving by means of the printing press.

In a short paper which was read before the Royal Society in 1846, and is now deposited in the Archives of that body, the subject of these pages was treated of, first, as regards its relations to electrical science, and secondly, in reference to its application to the arts: since, however, it may reasonably be presumed that many of those into whose hands these remarks in their present form may fall, are wholly unaquainted with the process itself, I purpose here to deviate from the former plan by commencing in the first place with an account of the apparatus employed, and the mode of executing the process, then proceeding to speak briefly of its practical application to the arts, and, lastly, to offer a few words on its relations to electrical science.

As there is, as already observed, a marked difference between the present process and that usually described under the same title, not only as regards the nature of the action, but also in the appearance of the effect produced, so will it be found that there is of necessity a corresponding diversity in the nature of the apparatus employed in the two instances. Whilst the electro-engraving *viâ humidâ*, if it may be so distinguished, can be effected by a single battery of the kind invented by Mr. Smee, the present process is found to require at least from four to eight of these batteries, furnished with the additional aid of the electro-magnetic coil.

The mode of arrangement of the apparatus which I adopt, and find to be the most convenient, is the following: Having united six moderate-sized Smees' batteries, and included likewise an electro-magnetic coil in the circuit, I attach the steel plate or blade to be engraved upon to the zinc extremity of the batteries, the electro-magnetic coil being interposed between the plate and the zinc: then taking the wire connected with the platinized silver of the batteries in my hand, I use it as an etching tool or graver on the steel plate,—an electrical spark of great brilliancy, accompanied by a slight indentation, or biting-in of the steel, being the result of each contact of the wire with the plate.

From this description it will be at once apparent that as a mark is effected only at the time when the contact between the poles is made and broken, the method of working must necessarily consist as it were of a succession of dots; by a little practice, however, a facility is acquired in this mode of manipulation, which renders it less tedious than might be supposed; whilst its perfect cleanness, and freedom from the employment of acid, together with the peculiar effect of the spark, which constantly marks the progress of the work, are circumstances which lend to the process a character at once interesting and pleasing.

It is found necessary, in order to protect the hand from shocks to which in the above operation it would otherwise be exposed, that the wire employed as the graver should, at the part at which it is held, be carried through some non-conducting handle, for which a tube of glass was, in the first instance, had recourse to; subsequently however, a crotchet needle-holder,* drilled through, and with the wire passing through it, has been found to afford a convenient substitute for the glass handle at first adopted. The point of the wire used as the graver should consist either of platina or of gold, and it should be kept clean, and finely pointed by means of a fine file, whilst the small screw at the end of the crotchet needle-holder enables the operator to regulate the length of the point with which he works, to substitute a new one as the old becomes worn out, or to employ wires of different metals at pleasure.

It may be observed also, that much seems to depend on the angle of inclination at which the wire used as the etching tool is held—as in some instances it appears, when run along by the edge of a ruler, and held at a certain inclination, to cut the steel in nearly the same manner as a diamond does glass.

The plate or blade to be engraved upon, should be secured in a small hand-vice, such as is used by watchmakers, to the handle of which the wire from the zinc extremity of the batteries is to be attached, and it will be found advisable in every instance to regulate the power of the current to suit the effect which it may be desired to produce, which is to be done either by increasing or diminishing the number of the batteries, or by employing a coil of greater or less magnitude, or one furnished with a handle moving over numbers to indicate the degree of power, as is the case with those used for the administration of electro-magnetism for medicinal purposes.*

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* Ivory handles, answering to this description, are to be met with at almost any of the shops for the sale of Berlin wool, &c.

The formation of designs has further been found to be much facilitated by laying patterns of them on the steel, when by first dotting out the outline, and afterwards carrying the wire more freely round the edge of the pattern with a kind of scratching motion, it will be found that the progress of the work is much expedited.

It has been thought desirable not to omit the notice of the minute circumstances here detailed, which, although in themselves apparently trifling, are nevertheless such as are very nearly concerned in ensuring the success of processes of the kind now under considertion.

By reversing the arrangement of the poles above described, and attaching the wire forming the graving tool to the zinc of the batteries, and the plate to be engraved upon to the platinized silver, a very different effect is produced. With the apparatus thus arranged, the spark that results from the contact of the wire with the steel plate is accompanied by a deposition of a minute portion of the substance of the wire on the steel; a circumstance that was at first thought to favour the supposition that this reversed arrangement of the poles might be taken advantage of by using a graving point of different kinds of wire to deposit various metals on polished steel plates or blades. And this object may indeed to a certain extent be realized, though on further experiment, an objection is found to arise to this application of the process for, although various metals according to the nature of the wire employed, as gold, platina, silver, &c., may thus be deposited at each contact, the deposition thus effected, unless very carefully conducted upon the purest steel, is in this instance attended apparently by an oxidation, giving rise to a charred appearance of the steel immediately around the point of deposit, a circumstance which materially interferes with the application of the process, under this form of arrangement, to any useful purpose.

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* The whole of the apparatus above described will perhaps be better understood by a reference to the accompanying plate, (plate ii., fig. 1,) in which is represented a table or stand containing the whole arranged in sitû. The table is furnished with two shelves, the lower of which serves for the reception of the batteries, whilst the upper, except as affording a stand for the coil, is appropriated as a desk for the use of the operator.

Where, however, the wire in connection with the platinized silver of the batteries is employed as the etching or graving tool, and the steel plate or blade to be engraved upon is attached to the opposite pole, no such oxidation or charred appearance is to be observed, unless occasioned by some defect in the steel; in this instance a portion of the steel appears to be simply transferred, at the time of the contact and spark, to the wire used as the graver—the effect thus produced being illustrated by the accompanying drawings. (Plates I.,—II., fig. 2.)

II

In reference to the application of this method of engraving to the arts, it appears to me to be almost limited to the production of such effects as are obtained by the last-mentioned arrangement, in which the graving wire is connected with the platinized silver of the batteries. As already stated, the effect thus obtained is manifestly quite unsuited to supersede the ordinary methods of engraving or etching for the use of the printer, though I have succeeded in producing a sufficiently distinct impression from a plate thus engraved, on submitting it to the copper-plate press.

The production, therefore, of various ornamental designs, on sword blades, knives, razors, or other instruments of polished steel, which would be too hard to admit of being engraved by the ordinary means, but which by this method may be embellished, after their purchase, with the coat of arms, crest, name, or initials, &c., of the owner, is the purpose for which the process is more particularly designed, and for which the whiteness of the mark produced, contrasted with the dark surface of the polished steel, renders it peculiarly adapted. In every case, a regulation of the strength of the galvanic current by the due adjustment of the batteries and coil, together with attention to all the other points formerly insisted on, is necessary to ensure a sharp and well-defined outline; that this effect, however, may readily be obtained by the employment of an ordinary degree of care and skill on the part of the manipulator, is shown by a reference to the accompanying lithographs, the first of which (facing the title-page) represents a fac-simile of a design on a steel plate which was exhibited in illustration of the process before the Royal Society in 1846; whilst fig. 2, plate II., shows the effect as applied to the blade of a knife.

It may here be observed also that the purer and harder the steel, the more beautiful will be the effect produced, so that the process may in this respect claim to serve almost as a test for the quality of the steel—any flaw or impurity being at once detected by the absence of that brilliant whiteness which is characteristic of the electrical engraving under favourable conditions.

The employment of this mode of etching or engraving is likewise capable of being applied to other metals, and marks of a similar description may be formed by it on burnished gold, &c.; but the effect thus produced, even in the instance of gold, is so much inferior to that on steel, as to render it of comparatively little value.

III.

Notwithstanding that the combustion of the metals by voltaic electricity was well known, and excited considerable attention amongst philosophers so long since as the beginning of the present century, and has from that period been made the subject of familiar exhibition in the lecture room, the transfer, during the deflagration, of a portion of the metal of one pole of the battery to the other, has not, so far as I am aware, attracted any notice previous to the discovery of the process under consideration, and indeed from an observation of this fact it was that the process itself took its origin.

It is not, however, merely as forming the foundation of this process that the fact in question is deserving of attention. It will be found further to present some topics of interest in its relations to electrical science, by tending materially to influence the received opinion in regard to the character, and extent of the voltaic power in its operation on metals.

Not having an opportunity of making direct reference to the able writings of Professor Faraday, I avail myself of the authority of Mr. Smee, who, after passing a well-merited eulogium on the distinguished author just mentioned, proceeds to state —"He" (Professor Faraday) "has shown that we can only reduce metals on the negative pole of a galvanic battery from a solution which contains them in combination with some other substance; *for if we galvanize a metal in the elementary state for ever, the voltaic power would have no property to move it to either electrode.* He has also proved that not only must the metal be combined in the definite chemical proportion to form a metallic salt, but in order that it may be decomposed it must be in that peculiar physical state called liquidity or fluidity."* Regarding this then as a true exposition of the present state of opinion on this subject, the extent to which it is affected by the facts developed by the present process must be at once apparent, since it is manifest that the foundation of the process itself rests on the very property, the existence of which is denied in the passage above quoted,—the property which the voltaic power possesses of moving a metal not only when in an elementary, but even when in a solid state, from one electrode or pole to the other.

Nor is this a solitary instance of the interest which attaches to this fact in a scientific point of view. It seems calculated likewise to throw some light on a question which has been ingeniously raised by Mr. Smee, who, in reasoning on the

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* Elements of Electro-metallurgy, p. 128, 2nd edition, 1843.

rationale of the electro-motive force in the reduction of metals, has started the hypothesis that the reduction of a metal from its solution may be wholly due to the liberation of the hydrogen of the decomposed water, and is not necessarily the result of the direct influence of the voltaic action. "If," says Mr. Smee,* "we find a body at the pole of a battery, it is by no means certain that it has passed by direct decomposition of the voltaic current; because, if the compound of which it formed a part was dissolved in water, the elements of the latter being set free, often act in an important way to form new combinations, which result from the secondary effects; thus the aqueous solution of a metallic salt, for instance, copper, being subjected to a voltaic current, has hydrogen presented at the cathode, and oxygen at the anode. But at the same time this change is taking place, oxide of copper is passing to the cathode and sulphuric acid to the anode. The hydrogen seizes upon the oxygen of the oxide of copper, and forms water, whilst metallic copper is thrown down on the electrode or pole, ***not by direct voltaic action, but as a secondary effect attributable to the hydrogen.***"

Now whilst the power of hydrogen to effect the reduction of a metal from its solution, as here contended for, is at once fully conceded, the fact of the direct transfer of the metal from one pole of the battery to the other, as in the instance of the present process, must, on the other hand, be admitted as a sufficient evidence of the adequacy of the voltaic power to effect such reduction or transfer quite independently of any extraneous aid or influence. And since the galvanic force thus displays the constancy of its possession of this power of transfer even under the unfavourable conditions presented by the direct contact of the poles in a dry state, there certainly appears no reason why it should not retain and exert the same property in every case when operating on metals in a state of solution.

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* Elements of Electro-metallurgy, p. 49.

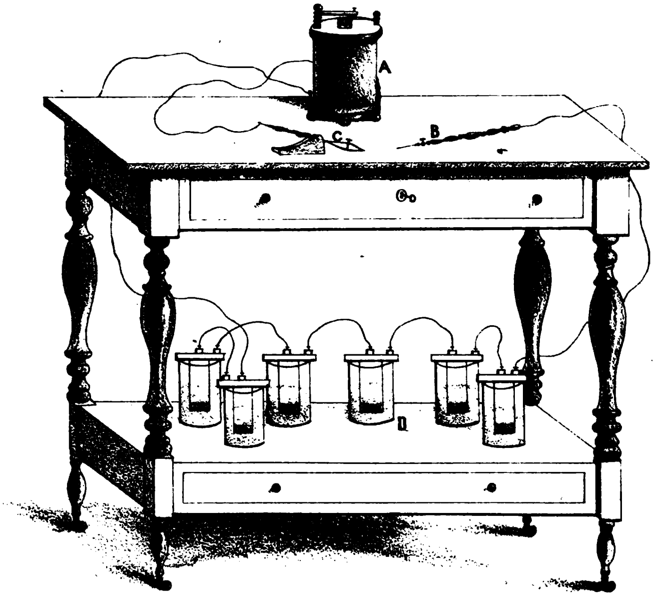
Without therefore attempting wholly to invalidate the proposition of Mr. Smee, but admitting that the evolution of hydrogen may possibly play some part in the reduction of metals from their solution, the supposition of a case in which the direct or primary power of galvanism, as exhibited in the present process, is wholly suspended in order to permit another power to come into sole operation, and reduce the metal, "not by direct voltaic action, but as a secondary effect attributable to the hydrogen," appears to me to be hypothetical in the extreme.

Before quitting this subject it is worthy of remark, that, as in the process of electrotype, where the poles of the battery are connected by a fluid medium, so in the present case, where they are brought into immediate contact, the transfer of the metal already alluded to always takes place in a uniform and determinate direction, though, relatively to the electrotype, in an inverted order;—the metallic deposit or transfer taking place in the present instance *from* the wire in connection with *the zinc*, *to* that attached to *the platinized silver* extremity of the batteries.

Whilst then the process forming the subject of the present description offers these new points of general interest to the growing science of electricity, it seems only proper, in concluding this brief notice, to state, in reference to the practical adoption of this method of engraving for the purpose of producing ornamental and other designs on steel, that, under the employment of a skilful artistic manipulation, it is susceptible of affording results of a character far surpassing any thing that has hitherto been obtained by it, and that the illustrative drawings are to be regarded as representing only imperfect specimens of its real capabilities.

J. WHEREAT, PRINTER, GAZETTE OFFICE, WESTON-SUPER-MARE.

Fig. 1.



A *The Electro Magnetic Coil.*
B *The Crochet needle holder, serving as the Graving Tool*
C *The hand vice for securing the blade or object to be engraved upon.*
D *The galvanic batteries.*

Fig. 2.

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